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RESEARCH ON FERROELECTRIC MATERIALS FOR MILLIMETER WAVE APPLICATIONS

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A. PROGRESS

In the current reporting period a study has been initiated concerning the tradeoffs in millimeter wave component design between the use of low-loss ferroelectric materials and conventional ferrites. The object of this study is to quantify advantages and disadvantages in a radar system context specifically for the planar dielectric lens and for individual phase shifters. The results of this study will clarify the potential utility of ferroelectrics and specify a range of materials parameters which are faborable for the selected radar system applications.

Another effort recently begun is the measurement of TiO_2 single crystal samples from 30-40 GHz and from 90-100 GHz. These crystals have relatively high dielectric constants (~ 100) at microwave frequencies and show low loss. Thus, these measurements will provide a rigorous test of the analysis methods currently being used on the ferroelectric samples.

Material research is an important part of this work; and hence the selection of a suitable class of materials is a major task. In the present work, the tungsten bronze and perovskite structural families have been selected since these families offer a wide range of compositions exhibiting excellent electo-optic, dielectric, piezoelectric and other properties. At present, several bronze compositions such as $Sr_{.6}Ba_4Nb_2O_6$, $Pb_{1-x}Ba_xNb_2O_6$, $Sr_2KNb_5O_{15}$ and $Ba_{2-x}Sr_xK_{1-y}Na_yNb_5O_{15}$ are now available from our current DARPA and other contracts. and have been evaluated. The work on these crystals is interesting and based on these results, the necessary changes in compositions are being made. The Czochralski bulk single crystal growth technique has successfully been established to develop approximately 1.5 to 1.8 cm in diameter $Sr_{.5}Ba_{.5}$-Nb_2O_6 crystals. The crystals are of excellent quality and high frequency dielectric measurements are in progress on this crystal.

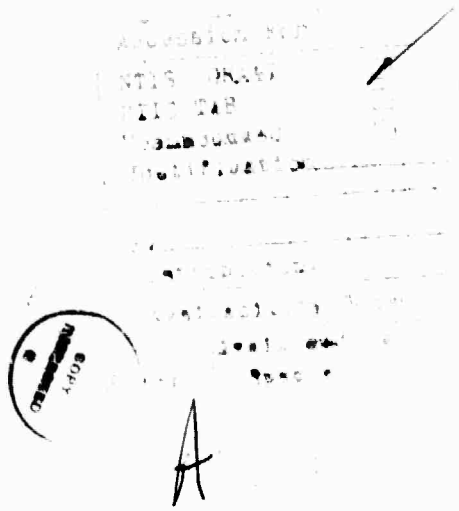
Recently, the tungsten bronze solid solutions systems $Pb_{1-2x}K_xM^{3+}_xNb_2O_6$, M= La or Bi, have been developed and some of the compositions in these systems appear to be promising for study of their high-frequency dielectric properties.

Chief, [illegible] Division

All of these compositions possess orthorhombic tungsten bronze structure and will be evaluated in terms of their usefulness for millimeter wave applications.

B. MAJOR EQUIPMENT

A new crystal puller unit has been installed and is now available for current growth work on tungsten bronze family crystals.



C. CHANGES IN PERSONNEL

Nothing to report.

D. TRIPS, VISITS AND PAPERS

The following two papers from our current work have been submitted for publication:

1. "Structural and dielectric properties of the phase $Pb_{1-2x}K_xM_x^{3+}Nb_2O_6$, M= La or Bi, " R. R. Neurgaonkar, J. R. Oliver, W. K. Cory and L. E. Cross.

2. "Low and high frequency dielectric properties of ferroelectric tungsten bronze $Sr_2KNb_5O_{15}$ crystals " R. R. Neurgaonkar, W. W. Ho, W. K. Cory, and W. F. Hall and L. E. Cross.

E. PROBLEMS

Nothing to report.

F. FUTURE PLANS

Bulk single crystal growth of the tungsten bronze composition $Ba_{2-x}Sr_xK_{1-y}Na_yNb_5O_{15}$ for microwave dielectric characterization will be continued. Based on these results, the necessary changes in crystal composition will be made.

Further investigations of the millimeter wave dielectric properties of SBN and other bronze compositions (PKLN) will be carried out, including measurements of reflection and transmission at elevated temperatures in the frequency range 30-40 GHz. Certain other ferroelectric crystals will also be examined. The work on TiO_2 single crystal will be continued.

G. FISCAL STATUS

Current Amount provided:	$ 354,382
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This effort is an attempt to grow and measure the millimeter-wave properties of tungsten Bronze Ferroelectrics. Difficulties (apparently with the growth) have stalled progress during this period.

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